

INTEGRATED FORCE SENSITIVE LENS AND SOFTWARE

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] The present application is a continuation-in-part of International application no PCT/US2007/019606 filed 7 Sep. 2007, which designates the United States.

BACKGROUND OF THE INVENTION

[0002] (1) Field of the Invention

[0003] The present invention relates to input devices for electronics and, more particularly, to a touch sensitive input panel or display with small form factor especially suited for use in cellular phones and personal digital assistants (PDAs), PC Tablets, as well as laptops, PCs, office equipment, medical equipment, or any other device that uses touch sensitive displays or panels.

[0004] (2) Description of Prior Art

[0005] Touch screens are being deployed in an increasing number of products using an array of several types of technology. Market analysts predict that in the mobile telephony market, touch screens will increase from less than 10% penetration to more than 50% penetration by 2010, assuming the cost of these touch screens are reduced to a low enough level. It is possible that resistive based touch screens can support low enough prices, but it is certain that force sensing resistor based touch screen can be produced at low enough cost to support this type of market projections.

[0006] As consumer products continually decrease in size and increase in user interface complexity and display advancements, the demand for inexpensive, low-profile and precise touch screens is increasing. Indeed, when used in a smaller electronics device the sensor must also be thin, i.e., less than about 1 mm thickness, yet be robust and durable.

[0007] In today's electronic industry the manufacturer of an electronic device utilizing a pressure sensitive touch sensitive display solution will look to their display supplier and solution providers for new low cost highly functional touch screens.

[0008] There are several types of technologies used in implementing touch sensitive screens that can detect the application of fingers and other passive objects. For example, resistive pads comprise two conductive plates pressed together. The disadvantage of a resistive pad is that the resistive membrane material will wear out, initially resulting in further reduced clarity followed by dead spots. In addition, the production yield is typically rather poor and the technology has a few disadvantages such as a fixed (non-user adjustable) actuation force and the light throughput through the resistive membranes is typically only around 70% to 75%, reducing display visibility.

[0009] Capacitive touchpads operate by measuring the capacitance of the passive object to ground, or by measuring the alteration of the trans-capacitance between different sensors.

[0010] An example of a capacitive touchpad is described in U.S. Pat. No. 5,495,077 to Miller.

[0011] Capacitive pads are relatively expensive to manufacture compared to resistive, and can only detect objects with sufficient capacitance. Small objects, such as the end of a regular stylus or pen, do not have enough capacitance to ground or trans-capacitance to be detected by a capacitive

touchpad. Moreover, the actuation force is predetermined and may be as low as 0 grams force, in which case the touch screen may register a touch even before the user's finger touches the screen. This often leads to difficulties in implementing certain end-user features, such as handwriting recognition.

[0012] Surface acoustic wave devices operate by emitting sound along the surface of the pad and measuring the interaction of the passive object with the sound. These devices work well, but are generally much too expensive for general applications.

[0013] Infra red light based displays work in a similar fashion, but this technology typically adds a large size and a high cost increase.

[0014] Finally, there are devices that use force sensors to measure the location and magnitude of the force exerted by the passive object on the touchpad. A force sensitive touchpad will sense force applied by any sort of passive object, regardless of the electrical conductivity or composition of the object. Such devices were originally described in U.S. Pat. No. 3,657,475 to Peronneau et al. and U.S. Pat. No. 4,121,049 to Roeber. These devices measure the forces transmitted by the touchpad to a fixed frame at multiple points e.g., at the corners of the pad. Roeber '049 discloses a mathematical formula for deriving the position and magnitude of the force applied by a passive object from the forces measured at the multiple points.

[0015] As another example, U.S. Pat. No. 4,511,760 to Garwin et al. issued Apr. 16, 1985 shows a force sensing data input device responding to the release of pressure force. The input surface is provided with a transparent faceplate mounted on force-sensing piezoelectric transducers. Preferably, four piezoelectric transducers are provided, one at each corner of a rectangular opening formed in the frame. To determine the point of application of force on the input surface, the outputs of the four transducers are first summed. To constitute a valid data entry attempt, the sum must exceed a first threshold while the user is pushing on the input surface. When the user releases his finger, a peak of the sum is detected, which is of opposite polarity from the polarity of the sum for the pushing direction. The individual outputs of the four sensors at the time that the peak of the sum occurs are used to calculate the point of application of the force.

[0016] United States Patent Application 20030085882 by Lu published May 8, 2003 shows a touch pad device having a support layer with a plurality of strain gauges in a matrix configuration. A touch layer is disposed on top of the strain gauge matrix, the touch layer being joined to the top of the strain gauge matrix. Sensor wires connect the strain gauges to a processor which is programmed with an algorithm to measure the location and pressure of simultaneous, multiple touches.

[0017] United States Patent Applications 20040108995 and 20040021643 both by Hoshino et al. show a display unit with touch panel mounted above a display via four differentially-mounted sensors. The pressure sensors detect force with which a pointing device such as a finger pushes the panel surface, in real time. The force P with which the pointing device such as a finger pushes the panel surface is found from the following equation irrespective of the pointing position: $P=a+b+c+d-a_0+b_0+c_0+d_0$, which equation detects dragging of a cursor.

[0018] United States Patent Application 20050156901 by Ma et al. issued Jul. 21, 2005 shows a touch screen display system with a display screen and overlying touch surface. An